

Random Site Steelhead Surveys, Wenatchee Basin, 2004-2005

Abstract

Steelhead surveys were conducted at randomly-selected sites in Wenatchee basin 2004-05. The goal of the random-site surveys was to complement existing index reach steelhead surveys. In 2004-2005, random-site steelhead surveys described previously undocumented redd locations in Beaver Creek, Chumstick Creek, and Mission Creek. In mainstem Mission Creek, every 2004-05 random site sampled contained steelhead redds, suggesting Mission watershed might be a good candidate for an additional index survey in the less-documented lower Wenatchee basin. The addition of random-site steelhead surveys to existing index surveys enhances our ability to extrapolate from index reaches to the entire Wenatchee basin, and furthers understanding of the status and trend of natural steelhead spawning in Wenatchee basin.

Introduction

Steelhead returns to Wenatchee basin can be roughly approximated by the difference in steelhead counts at Rock Island dam (on the Columbia downstream of Wenatchee River) and Rocky Reach dam (on the Columbia upstream). Steelhead counts from these two dams are available 1977-2005 (www.fpc.org) and indicate that Wenatchee basin adult steelhead returns have ranged 520 – 9968 over this period (average 3739). Highest returns since 1977 occurred in the 5-yr interval 1983-1987 (range 5534 – 9968, average 8011), and lowest returns in the 5-yr interval 1996-2000 (range 520 – 2243, average 1369). In the 5 years since this low-return interval, the steelhead run has returned towards the typical condition for the period of record; 2001-2005 adult interdam steelhead counts ranged 2710 – 6575 (average 4312).

Tumwater dam counts averaged 39% of Columbia River interdam counts across all years 2001-05; the percentage varied widely annually but the median annual percentage was 38% (WDFW 2005). Similarly, a 1999-2000 radio-telemetry steelhead study found that 37% of (30 of 82) radio-tagged steelhead entering Wenatchee basin went above Tumwater dam (English et al 2001). 73-94% of redds (median 93%) counted by WDFW 2001-2005 were above Tumwater dam (WDFW 2005).

A substantial portion of adult steelhead returns are to the lower Wenatchee basin (below Tumwater dam). It is unknown what percentage of lower basin adults spawn successfully but our understanding of spawning patterns in lower Wenatchee basin appears to be limited compared to our understanding of upper basin spawning.

Above Tumwater dam, there appears to be relatively little steelhead spawning in tributaries above Lake Wenatchee, including White and Little Wenatchee watersheds (WDFW 2005). Thus the Tumwater dam steelhead count is likely composed principally of fish that will spawn in the Upper Wenatchee mainstem/tribs, Chiwawa watershed, and Nason watershed.

1999-2000 radio-telemetry detected steelhead in the Wenatchee mainstem and in six tributaries (English et al 2001). Of detections in tributaries, 25-30% were in three tributaries above Tumwater dam (Chiwawa, Nason, and Chiwaukum) and the rest were in three tributaries below Tumwater (Mission, Peshastin, and Chumstick)¹ (English et al 2001).

Based on WDFW expanded redd counts 2002-05² the median redd count in Wenatchee basin was 488 redds. Roughly half of WDFW-documented redds are in Wenatchee mainstem (median 288 redds), and roughly ¼ are in Nason mainstem (median 123 redds). Most of the remaining redds are found in Clear Creek³ (median 35), Peshastin mainstem (median 32), Chiwawa mainstem (median 27) and Icicle Creek (median 20). Small numbers of redds also occur in several other tributaries (median redd counts less than 10) (WDFW 2005).

Redd counts in 2005 were much higher than in previous years, roughly double 2002-2004 counts, and this pattern was seen in Wenatchee mainstem, Chiwawa watershed, Nason watershed and Peshastin watershed. However redd counts did not increase 2005 in White, Little Wenatchee and Icicle watersheds (WDFW 2005).

Hatchery-reared juvenile steelhead have been released at various locations in Wenatchee basin over the past several decades (A. Murdoch, pers. comm.). The listing of Upper Columbia steelhead as endangered in 1997 spurred a change in steelhead stocking practices. Beginning in 1998, steelhead stocking in Wenatchee basin has been of Wenatchee broodstock only, from adults collected at Dryden and Tumwater dams (A. Murdoch, pers. comm.). Leavenworth National Hatchery on Icicle Creek in Wenatchee basin discontinued rearing and releasing steelhead in the mid-1990s (*get exact date and reference*).

Since 1998, Washington Department of Fish and Wildlife (WDFW) has released around 300,000 juvenile steelhead per year in Wenatchee basin; the exact number has varied annually (A. Murdoch, pers. comm.). From 1998 to present all releases have been upstream of Tumwater dam. Since 1998, Nason watershed has received only wild x wild crosses, Chiwawa watershed

¹ In table F2, English et al. 2001 list number of fish detected by tributary and date, but it cannot be ascertained their publication whether repeat observations are of the same or different individuals. If we compare the greatest number of individuals detected on any one date in each tributary (the minimum number of individual fish observed in that tributary) the data are: 14 detections in lower tributaries (6 in Peshastin, 4 in Mission, 4 in Chumstick) and 6 detections in upper tributaries (3 in Chiwawa, 2 in Nason, 1 in Chiwaukum). If we compare the total number of detections per tributary, summing across all dates (the maximum number of individuals that could have been observed in the tributary), the data are: 30 detections in lower tributaries (18 in Peshastin, 6 in Mission, 6 in Chumstick) and 10 detections in upper tributaries (7 in Chiwawa, 2 in Nason, 1 in Chiwaukum).

² Counts from 2001 are not included since several reaches sampled 2002-05 were not sampled in 2001.

³ Clear Creek is a small tributary of Chiwawa River that in most years has higher redd counts than Chiwawa mainstem; in most years Clear Creek contains over half the spawning in Chiwawa watershed. In 2005 Clear Creek redd counts were unusually low and Chiwawa mainstem redd counts were unusually high, possibly due to unusually low flows limiting access into Clear Creek.

has received only hatchery x wild crosses, and upper Wenatchee mainstem has received some hatchery x wild and some hatchery x hatchery crosses.

Since 1998 the proportion of stocked juveniles that were adipose-clipped varied yearly. Very few stocked fish returning as adults in 2005 would have been adipose-clipped. Approximately 20% of stocked fish returning in 2006, and approximately 50% of stocked fish returning in 2007 are expected to be adipose-clipped (A. Murdoch, pers. comm.).

In 2005, 1) redd counts and 2) adult returns above Tumwater approximately doubled relative to 2002-04 counts (WDFW 2005). The redd count increase occurred in both the upper (above Tumwater) and lower Wenatchee basin. A strong increase in redd counts (15 to 34 to 97) was seen over the record of survey (2003-05) in Peshastin watershed (below Tumwater dam), where no hatchery steelhead have been released since 1998 (WDFW 2005). The straying rate of Wenatchee hatchery steelhead releases has been estimated at 15-18% (English et al 2001), so it is unlikely that stocking alone accounts for the 2005 spawning increase.

Radio-telemetry compared the percentage of wild fish tracked to above Tumwater dam (57%) to the percent wild below Tumwater dam (40%) (English et al 2001). Tumwater dam data 2001-2005 indicates that for upper basin adult females, the percentage of wild fish ranged 30-69% annually, and averaged 48% (WDFW 2005).

The last 5 years appear to have been fairly typical in terms of total steelhead returns to Wenatchee basin, although stocking practices have altered. Although about 40% of the run appears to pass above Tumwater, a much larger percentage of enumerated redds are above Tumwater. Upper basin (above Tumwater) fish appear to have a higher percentage of wild heritage and may be more successful spawners. Of documented upper basin spawning, roughly 75% is in mainstem Wenatchee and mainstem Nason.

Lower basin spawning may be less well described than upper basin spawning. Of documented lower basin spawning, roughly 95% is in mainstem Wenatchee and mainstem Peshastin. Higher redd counts in 2005 were not confined to upper Wenatchee watershed; higher redd counts occurred in lower Wenatchee watershed as well and could not be attributable simply to straying of fish stocked above Tumwater.

In 2004-2005, we conducted steelhead redd surveys at randomly-selected sites in Wenatchee basin. Our goal was to complement existing index reach steelhead surveys conducted by Washington Department of Fish and Wildlife (WDFW) since 2001. Specifically, we hoped to 1) quantify the proportion of spawning occurring outside of annually monitored reaches, and 2) document potential changes in steelhead distribution, which might be occurring simultaneously with changing redd densities in annually monitored reaches. Random-site surveys also help to confirm upper limits of spawning. By adding random-site steelhead surveys to existing index surveys we hope to enhance the ability to extrapolate from index reaches to the entire Wenatchee basin, furthering understanding of the status and trend of natural steelhead spawning in Wenatchee basin.

Methods

Study Design

Twenty-five random sites are selected each year, based on a 5-yr rotating-panel design (Hillman 2004). For steelhead surveys, we selected only anadromous-accessible sites from this list.

To maximize consistency with WDFW index surveys, our field protocol and data collection were adopted from WDFW, and our crew cross-trained with WDFW. On each visit water temperature was recorded (handheld thermometer), adult steelhead were noted, and redds were counted, categorized, flagged, and GPS'd (spatial location recorded with a Global Positioning System). Redds were categorized as incomplete, complete, faded, or erased (see definitions in Appendix B).

The major protocol difference between Wenatchee basin random-site and WDFW index surveys is that the random reaches are visited 3-4 times during the spring, in contrast to index reaches which are surveyed weekly from late March through end of May.

Protocol improvement based on 2004 beta-test

WDFW samples at two different intensities, extrapolating from one to the other. WDFW visits index areas weekly, and extrapolates to expansion areas visited once annually (WDFW 2005).

In 2004, random sites which fell within WDFW expansion areas were sampled by both our study and WDFW. Beginning in 2005, the protocol was changed to eliminate duplicate sampling and increase sampling coverage; areas sampled even once by WDFW were not also sampled by USFS. In 2004 26 sites were sampled by Forest Service (FS) crews, four of which were in WDFW expansion areas and were also sampled by WDFW. An additional 7 random 2004 sites were within WDFW index areas, making a total of 33 random reaches sampled in 2004.

In 2005 25 sites were visited by FS crews, and an additional 31 fell into WDFW index *or* expansion areas, making a total of 56 random reaches sampled in 2005 (table one). Random sites within WDFW reaches were re-sampled with GIS based on GPS'd redd locations.

Reach selection

Sites on the randomly-generated list were dropped (not sampled) for any of the following reasons: reach midpoint was above a permanent or temporary anadromous barrier, safety/inaccessibility, landowner denial, or absence of a defined channel (table one). See Appendix A for a list of sites kept and dropped, and reason for dropping sites.

Number of visits

Our protocol is to visit each random reach at least three, preferably four times, as safety allows. In 2004-05, 46 reaches received four or more visits, three reaches received three visits (4th visit precluded by safety concerns), and two reaches were visited fewer than three times⁴ (tables two and four).

Results

Relatively few sites (about 9% in 2004-05 combined) were dropped for logistical reasons such as safety or landowner denial (table one). Sites that were dropped were generally outside the sampling universe (for example above a barrier). The protocol change 2004-2005 increased the effective annual sample size to over 50 sites in 2005 which should increase the long-term power of the data collection (table one).

Steelhead spawning has been observed in Wenatchee basin at water temperatures 3.7 - 10.3 C (WDFW 2005). Water temperature exceeded 3.5 C on at least one visit to all FS-sampled random reaches (table one).

In 2005 steelhead redds were observed in two of the 25 reaches visited by FS (Forest Service) crews. Both of these random reaches were in Mission Creek drainage (table 2). An additional 31 random locations fell within WDFW reaches in 2005, and will be re-sampled with GIS (table three).

In 2004 26 random reaches were visited by FS crews (table four). At four of these reaches FS crews documented steelhead activity in known spawning reaches within WDFW expansion areas in Nason, Peshastin, and Wenatchee River. Steelhead activity was also observed in two new locations in random reaches in Chumstick and Beaver Creeks, and in Mission Creek above Sand Creek during a one-visit crew training.

An additional five random reaches fell within WDFW index reaches in 2004 (table 5).

Tables six and seven give details on location and condition of FS-surveyed redds in 2005 and 2004, respectively.

⁴ Zero 2004 sites and two 2005 FS random reaches were visited less than three times. Big Meadow Creek in the meadow (site 146) had no spawning gravels (100% fines) and was therefore visited only once. Chiwawa above Phelps (site 168) had water temperatures below sampling minimums in the early season, and flows too high to sample safely in the late season, leaving only a short sampling window; it received only two visits.

Discussion

In 2004-05 combined, Four of 51 (7.8%) of random one-mile stretches outside of WDFW survey areas contained redds. 17 and 11 redds were found outside of WDFW index and expansion areas in 2004 and 2005 respectively, compared to 382 and 1140 (respectively) expanded redd counts for these years.

The area sampled annually by random sites outside of WDFW areas is 25 miles (40 km), roughly 6.6% of the approximately 602.7 km of anadromous stream in Wenatchee basin (S. Rentmeester, pers. comm.).

Because very few returning adults would have been adipose-clipped in 2004-05, our 2004-05 surveys could not address the origin of returning adults. In future, we will document any adipose-clipping observed.

2001-2005 WDFW index surveys have documented large shifts in the spatial distribution of redds (WDFW 2005). In some cases there are likely hypotheses to explain the shifts; for example, unusually low spring flows in 2005 reduced access to smaller streams and likely produced the observed shift out of small tributaries and into mainstems in 2005. In other cases the reasons for the shift are not understood, such as the shift in distribution within Wenatchee River above Tumwater 2004-05 vs. prior years (WDFW 2005). If similar shifts are occurring into and out of WDFW-surveyed reaches but are not quantified, power to quantify population status and trends will be reduced.

By providing a measure of the quantity and distribution of spawning occurring outside of WDFW index and expansion areas, random-site redd surveys help to 1) quantify the proportion of spawning occurring outside of WDFW reaches, 2) quantify shifts into and out of WDFW reaches, and 3) indicate whether steelhead may be expanding their distribution, as well as increasing redd densities within WDFW reaches. Random-site surveys also help to verify upper limits of spawning assumed by WDFW.

With only two years of data and 87 sample points (51 sample points outside of index areas), we currently have limited power to undertake these analyses. However at the completion of the expected 5 or more years of data collection a full analysis of the above issues should be possible.

In 2004-05, random-site steelhead surveys described previously undocumented redd locations in Beaver Creek, Chumstick Creek, and Mission Creek. Since our documentation of spawning in Beaver Creek in 2004, WDFW has added Beaver Creek to WDFW-surveyed index reaches. Available spawning habitat in Beaver Creek is fairly circumscribed and establishment of an appropriate index reach was straight-forward.

Chumstick and Mission Creeks have substantial area accessible to anadromous fish, and relatively little information on within-watershed spawning patterns. Like Peshastin Creek, they have no steelhead releases and would serve as “control” areas allowing description of trends in natural spawning in unstocked areas. Both are in the lower basin (below Tumwater) where

spawning appears to be less well-described by index reaches. However in both Mission and Chumstick watersheds, the high proportion of private land coupled with the inability to “float” the streams imposes logistical difficulties on redd data collection.

In Chumstick watershed, culvert replacement and habitat improvement projects designed to increase anadromous access are ongoing. Of 6 random sites surveyed 2004-05 in Chumstick watershed, one site in the lower mainstem had redds. A total of 2 redds and no adult steelhead were documented 2004-05 in Chumstick watershed.

Of 7 random sites in Mission watershed, 2 had redds; redds were also observed at a third site (non-random training site). No 1st-3rd order Mission sites sampled had redds, but all mainstem Mission sites sampled had redds. A total of 19 redds and 5 adult steelhead were documented 2004-05 in Mission watershed.

Mission watershed may be a good candidate for a systematic and/or whole watershed approach to assessing redd abundance, and evaluating possible establishment of an index area. Mission watershed appears to have significant steelhead spawning throughout the mainstem, and could provide another “control” area where no hatchery steelhead are being released, in the relatively less-described lower basin.

Table 1. All random sites considered (2004-2005)

	2004				2005			
	Sampled USFS	Sampled WDFW	Total Sampled	Not Sampled	Sampled USFS	Sampled WDFW	Total Sampled	Not Sampled
Total sites sampled	26	5	31	39	25	31	56	51
Number of sampled sites at which:								
Water temperature ≥ 3.5 C at least	26	5	31		25	?	?	
one survey								
redds observed	6 ^a	0	6^a		2			
Subtotal: Not in Avail Universe				38				44
Above permanent barrier				23				19
Above temporary barrier				7				5
No surface connectivity				7				18
Mapping error or in lake				1				2
Subtotal: Logistical Concern				1				7
Landowner denial				0				3
Inaccessible				1				2
Unsafe				0				2

^a Four of the six FS sites with redds were within WDFW extrapolation areas with redds (2 Nason mainstem sites, Peshastin mouth, Wenatchee mainstem).

Table 2. 2005 reaches surveyed (USFS)

Watershed	Stream	Site num	Survey Method	Date first surveyed	Date last surveyed	Num of surveys	First survey date with water temp ≥ 3.5 C	Num Surveys with water temp ≥ 3.5 C	Date first obsvd ST activity	Date last obsvd ST activity	Total Num Redds	Total Num ST
Chiwawa	Alder Creek	207	Wade	4/14/05	5/10/05	4	4/14/05	4			0	0
Chiwawa	Big Meadow Creek above Pole	20	Bank	4/14/05	5/11/05	4	4/14/05	4			0	0
Chiwawa	Big Meadow Creek Upper	146	Float	4/26/05	4/26/05	1	4/26/05	1			0	0
Chiwawa	Chikamin Creek at mouth	187	Wade	4/1/05	5/17/05	4	4/1/05	4	4/26/05	4/26/05	0	1
Chiwawa	Chiwawa below Schaefer	200	Float	4/1/05	5/20/05	4	4/1/05	4			0	0
Chiwawa	Chiwawa near 19 Mile CG	152	Float	4/15/05	5/20/05	4	4/27/05	3			0	0
Chiwawa	Chiwawa River above Phelps Ck	168	Wade	4/7/05	4/21/05	2	4/21/05	1			0	0
Chiwawa	Clear Creek above WDFW reach	191	Wade	4/5/04	5/23/05	4	4/5/04	4			0	0
Chiwawa	Minnow Creek Lower	4	Wade	4/11/05	5/26/05	4	4/11/05	4			0	0
Chiwawa	Minnow Creek Upper	130	Wade	3/31/05	5/17/05	4	4/26/05	3			0	0
Chiwawa	Rock Creek	138	Wade	4/6/05	5/18/05	4	4/13/05	3			0	0
Chumstick	Chumstick Ck above Clark Cyn	140	Wade	4/11/05	5/27/05	4	4/11/05	4			0	0
Mainstem	Beaver Ck above Mtn Meadows pond	170	Wade	3/31/05	5/17/05	4	3/31/05	4			0	0
Mainstem	Chiwaukum Creek below upper barrier	183	Bank	4/11/05	5/23/05	4	4/25/05	3			0	0
Mainstem	Deadhorse Canyon	11	Wade	3/29/05	5/10/05	4	3/29/05	4			0	0
Mission	King Canyon	127	Wade	4/6/05	5/24/05	4	4/22/05	3			0	0
Mission	Little Camas Creek	128	Wade	3/30/05	5/18/05	4	3/30/05	4			0	0
Mission	Mission Creek below Devil's Gulch	161	Wade	3/30/05	5/18/05	4	3/30/05	4	4/28/05	4/28/05	3	0
Mission	Mission Creek Lower	9	Wade	4/11/05	5/19/05	4	4/11/05	4	4/11/05	4/21/05	8	5
Mission	Sand Creek above Little Camas Ck	177	Wade	4/4/05	5/18/05	4	4/4/05	4			0	0
Mission	Upper Devil's Gulch	17	Wade	3/30/05	5/16/05	4	4/18/05	3			0	0
Nason	Mill Creek	172	Bank	4/13/05	6/1/05	4	5/19/05	2			0	0
Peshastin	Scotty Creek headwaters	206	Wade	4/13/05	5/26/05	4	4/13/05	4			0	0
White	White River above FS boundary	24	Float	4/1/05	5/25/05	4	4/1/05	4			0	0
White	White River Lower	196	Float	4/1/05	5/25/05	4	4/1/05	4			0	0

Table 3. 2005 WDFW random subsample

SITE	Site Name
3	Wenatchee above Chiwawa.
5	Wenatchee below Monitor.
6	Ingalls Creek.
7	Tumwater Canyon.
10	Tumwater Canyon.
19	Wenatchee below Deep
23	Wenatchee River
129	Wenatchee near Chiwawa mouth.
131	Wenatchee above Monitor.
132	Peshastin below Mill.
134	Little Wenatchee.
137	Nason above Coles
141	Nason above Gill
142	Nason below White Pine
144	Peshastin below Negro.
145	Chiwawa above Goose
148	Wenatchee above Tumwater
153	Peshastin mouth
154	Wenatchee in Plain
155	Chiwawa above Big Meadow
157	Wenatchee near mouth
158	Shaser Ck near mouth
159	Chiwawa below Big Meadow
160	Chiwawa above Raging
171	Chiwawa below Chikamin
174	Peshastin Creek
178	Icicle Creek near mouth
180	White River below Canyon Creek
186	Wenatchee River
199	Nason Creek
203	Nason Creek

Table 4. 2004 USFS random reaches surveyed

Reach num	Site num	Watershed	Stream Nason Creek below Coles C Wenatchee at Monitor Chiwawa at Big Meadow Rock Creek mouth Spromberg Cyn Peshastin at mouth Marble at mouth Nason at Butcher Wenatchee in Plain Chumstick at Moon Peshastin, Camas to Mill Sunitsch Cyn Tronsen at Blewett Pass Middle Shaser Tronsen at Bonanza CG Nason at Mill	Survey Method	Date first surveyed	Date last surveyed	Num of surveys	First survey date with water temp >= 38.5 F	Surveys with water temp >= 38.5	Date first obsvd ST activity	Date last obsvd ST activity	Total Num Redds	Total Num ST
1	WC503432-001	Nason		B/K	4/1/2004	5/3/2004	4	4/1/2004	all	4/14/2004	5/3/2004	4	2
2	WC503432-003	Wenatchee		C	3/15/2004	5/24/2004	9	WDFW		N/A	N/A	0	0
3	WC503432-055	Chiwawa		B/K	4/21/2004	5/26/2004	3	4/21/2004	all	N/A	N/A	0	0
4	WC503432-063	Chiwawa		B	4/21/2004	5/3/2004	3	4/21/2004	all	N/A	N/A	0	0
5	WC503432-009	Chumstick		W	4/1/2004	5/4/2004	4	4/1/2004	all	N/A	N/A	0	0
6	WC503432-011	Peshastin		B	4/1/2004	5/4/2004	4	4/1/2004	all	4/1/2004	5/4/2004	2	1
7	WC503432-015	Chiwawa		B	4/2/2004	5/27/2004	4	4/20/2004	2,3,4	N/A	N/A	0	0
8	WC503432-060	Nason		B/K	4/6/2004	5/24/2004	4	4/6/2004	all	4/6/2004	5/24/2004	1	0
9	WC503432-021	Wenatchee		C	4/1/2004	5/27/2004	8	WDFW		3/28/2004	5/16/2004	19	10
10	WC503432-022	Chumstick		W	4/14/2004	5/11/2004	4	4/14/2004	all	N/A	N/A	0	0
11	WC503432-024	Peshastin		C	3/15/2004	5/31/2004	10	WDFW		N/A	N/A	2	0
12	WC503432-025	Chumstick		W	3/24/2004	5/11/2004	4	3/24/2004	all	N/A	N/A	0	0
13	WC503432-152	Tronsen		W	3/26/2004	5/6/2004	4	3/26/2004	all	N/A	N/A	0	0
14	WC503432-027	Peshastin		W	4/7/2004	4/30/2004	4	4/7/2004	all	N/A	N/A	0	0
15	WC503432-029	Tronsen		W	3/26/2004	5/6/2004	4	3/26/2004	all	N/A	N/A	0	0
16	WC503432-153	Nason		B/K	4/13/2004	5/24/2004	4	5/24/2004	3,4	N/A	N/A	0	0

17	WC503432-032	Nason	Nason at Kahler	B/K	4/6/2004	5/24/2004	4	4/6/2004	all	N/A	N/A	0	0
18	WC503432-035	Chumstick	Dry Creek	W	3/31/2004	4/29/2004	4	4/8/2004	2,3,4	N/A	N/A	0	0
19	WC503432-042	Chumstick	Chumstick at Eagle	W	4/1/2004	5/12/2004	6	4/13/2004	2,3	4/22/2004	5/5/2004	2	0
20	WC503432-046	Peshastin	Negro Creek	B	3/23/2004	4/30/2004	4	3/23/2004	all	N/A	N/A	0	0
21	WC503432-047	White	White River at mouth	B/K	3/29/2004	5/26/2004	4	3/29/2004	all	N/A	N/A	0	0
22	WC503432-048	Chiwawa	Beaver at mouth	W	4/2/2004	5/17/2004	5	4/2/2004	all	4/2/2004	5/17/2004	15	29
23	WC503432-049	Mission	EF Mission	B & W	3/25/2004	5/10/2004	4	3/25/2004	all	N/A	N/A	0	0
24	WC503432-054	Peshastin	Ingalls at barrier	B	5/4/2004	5/27/2004	3	5/4/2004	all	N/A	N/A	0	0
25	WC503432-058	Wenatchee	Plainview at mouth	W	4/7/2004	5/25/2004	4	4/7/2004	all	N/A	N/A	0	0
26	WC503432-065	Chiwawa	Chiwawa at Willow L.	B/K	5/18/2004	6/2/2004	4	5/18/2004	all	N/A	N/A	0	0
27	WDFW trend	Wenatchee	Wenatchee	K	4/15/2004	5/21/2004	10	N/A	N/A	N/A	N/A	0	0

Table 5. 2004 WDFW random reaches surveyed (data preliminary pending final GIS analysis by NOAA).

Site num	Site name	Redds seen
WC-17	Chiwawa RM 1	?
WC-18	mouth Icicle	Yes ⁵
WC-36	Lower Ingalls Creek	?
WC-38	Chiwawa above Chikamin	0
WC-39	White above Napeequa	0
WC-61	Little Wenatchee below falls	0

⁵ Pers comm. Art Viola

Table 6. Redds encountered 2005 (USFS).

Watershed	Stream	Site Num	Redd num	WGS84 N	WGS84 W	Date first seen	Last date unfaded	First date faded	First date erased	Date of last survey	Num days from first seen until erased
Mission	Mission Creek below Devil's Gulch	161	1	47.40736	-120.50880	4/28/05	4/28/05	N/A	5/18/05	5/18/05	20
Mission	Mission Creek below Devil's Gulch	161	2	47.40736	-120.50880	4/28/05	4/28/05	N/A	5/18/05	5/18/05	20
Mission	Mission Creek below Devil's Gulch	161	3	47.40398	-120.50578	4/28/05	4/28/05	N/A	5/18/05	5/18/05	20
Mission	Mission Creek Lower	9	1	47.48244	-120.48607	4/11/05	4/11/05	4/21/05	5/19/05	5/19/05	38
Mission	Mission Creek Lower	9	2	47.4806	-120.48705	4/11/05	5/5/05	N/A	5/19/05	5/19/05	38
Mission	Mission Creek Lower	9	3	47.48028	-120.48745	4/11/05	4/21/05	5/5/05	N/A	5/19/05	>38
Mission	Mission Creek Lower	9	4	47.4832	-120.48590	4/21/05	4/21/05	5/5/05	5/19/05	5/19/05	28
Mission	Mission Creek Lower	9	5	47.4801	-120.18334	4/21/05	4/21/05	5/5/05	N/A	5/19/05	>28
Mission	Mission Creek Lower	9	6	47.47973	-120.48807	4/21/05	4/21/05	N/A	5/5/05	5/19/05	14
Mission	Mission Creek Lower	9	7	47.47761	-120.49014	4/21/05	5/5/05	N/A	5/19/05	5/19/05	28
Mission	Mission Creek Lower	9	8	47.47527	-120.49210	4/21/05	5/5/05	N/A	5/19/05	5/19/05	28

Table 7. Redds encountered 2004 (USFS)

Reach num	Site num	Watershed	Stream	Redd numbers	Date first seen	Last date unfaded	First date faded	First date erased	Date of last survey	Num_days visible unfaded	Num_days visible faded	Num_days from first seen until erased
1	WC503432-001	Nason	Nason Creek	Nason 1-1	4/14/2004	5/3/2004	--	--	5/3/2004	20	--	--
1	WC503432-001	Nason	Nason Creek	Nason 1-2	4/14/2004	5/3/2004	--	--	5/3/2004	20	--	--
6	WC503432-011	Peshastin	Peshastin at mouth	11-1	4/1/2004	4/15/2004	5/4/2004	--	5/4/2004	15	19	--
6	WC503432-011	Peshastin	Peshastin at mouth	Peshastin 11-2	4/1/2004	4/15/2004	5/4/2004	--	5/4/2004	15	19	--
8	WC503432-060	Nason	Nason at Butcher	Nason 60-1	4/6/2004	4/21/2004	--	5/13/2004	5/24/2004	16	--	37
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-8	3/28/2004	4/22/2004	4/29/2004	--	5/25/2004	26	27	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-9	4/1/2004	5/25/2004	--	--	5/25/2004	55	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-16	4/22/2004	5/25/2004	--	--	5/25/2004	34	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-31	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-32	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-33	4/29/2004	5/25/2004	--	--	5/25/2004	27	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-34	4/29/2004	5/25/2004	--	--	5/25/2004	27	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-35	4/29/2004	5/25/2004	--	--	5/25/2004	27	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-36	4/29/2004	5/25/2004	--	--	5/25/2004	27	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-40	5/18/2004	5/25/2004	--	--	5/25/2004	38	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-41	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-42	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-43	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-44	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	21-45	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--
9	WC503432-021	Wenatchee	Wenatchee	Wenatchee	5/12/2004	5/25/2004	--	--	5/25/2004	14	--	--

			in Plain	21-46								
9	WC503432-021	Wenatchee	Wenatchee in Plain	Wenatchee 21-53	5/18/2004	5/25/2004	--	--	5/25/2004	38	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	Wenatchee 21-54	5/18/2004	5/25/2004	--	--	5/25/2004	38	--	--
9	WC503432-021	Wenatchee	Wenatchee in Plain	Wenatchee 21-55	5/25/2004	5/25/2004	--	--	5/25/2004	--	--	--
11	WC503432-024	Peshastin	Peshastin - Camas	Peshastin 24-1	3/29/2004	5/31/2004	--	--	5/31/2004	63	--	--
11	WC503432-024	Peshastin	Peshastin - Camas	Peshastin 24-2	3/29/2004	5/31/2004	--	--	5/31/2004	63	--	--
19	WC503432-042	Chumstick	Chumstick at Eagle	Chumstick 42-1	4/22/2004	4/22/2004	5/5/2004	5/12/2004	5/12/2004	--	7	20
19	WC503432-042	Chumstick	Chumstick at Eagle	Chumstick 42-2	4/22/2004	5/5/2004	--	5/12/2004	5/12/2004	14	--	20
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-1	4/2/2004	4/2/2004	--	4/13/2004	5/17/2004	--	--	11
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-2	4/13/2004	4/23/2004	--	5/5/2004	5/17/2004	11	--	22
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-3	4/23/2004	5/5/2004	--	5/17/2004	5/17/2004	13	--	24
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-4	4/23/2004	4/23/2004	5/5/2004	5/17/2004	5/17/2004	--	12	24
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-5	4/23/2004	4/23/2004	5/5/2004	5/17/2004	5/17/2004	--	12	24
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-6	4/23/2004	5/5/2004	--	5/17/2004	5/17/2004	13	--	24
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-7	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-8	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-9	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-10	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-11	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-12	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12
22	WC503432-048	Chiwawa	Beaver at mouth	Beaver 48-13	5/5/2004	5/5/2004	--	5/17/2004	5/17/2004	--	--	12

Appendix A: All random sites considered (2004-2005)

SITE	YEAR	SURVEYABLE	REASON_DROPPED
3	2005	WDFW	WDFW
5	2005	WDFW	WDFW
6	2005	WDFW	WDFW
7	2005	WDFW	WDFW
10	2005	WDFW	WDFW
19	2005	WDFW	WDFW
23	2005	WDFW	WDFW
129	2005	WDFW	WDFW
131	2005	WDFW	WDFW
132	2005	WDFW	WDFW
134	2005	WDFW	WDFW
137	2005	WDFW	WDFW
141	2005	WDFW	WDFW
142	2005	WDFW	WDFW
144	2005	WDFW	WDFW
145	2005	WDFW	WDFW
148	2005	WDFW	WDFW
153	2005	WDFW	WDFW
154	2005	WDFW	WDFW
155	2005	WDFW	WDFW
157	2005	WDFW	WDFW
158	2005	WDFW	WDFW
159	2005	WDFW	WDFW
160	2005	WDFW	WDFW
171	2005	WDFW	WDFW
174	2005	WDFW	WDFW
178	2005	WDFW	WDFW
180	2005	WDFW	WDFW
186	2005	WDFW	WDFW
199	2005	WDFW	WDFW
203	2005	WDFW	WDFW
4	2005	SURVEY	SURVEYED
9	2005	SURVEY	SURVEYED

11	2005	SURVEY	SURVEYED
17	2005	SURVEY	SURVEYED
20	2005	SURVEY	SURVEYED
24	2005	SURVEY	SURVEYED
127	2005	SURVEY	SURVEYED
128	2005	SURVEY	SURVEYED
130	2005	SURVEY	SURVEYED
138	2005	SURVEY	SURVEYED
140	2005	SURVEY	SURVEYED
146	2005	SURVEY	SURVEYED
152	2005	SURVEY	SURVEYED
161	2005	SURVEY	SURVEYED
168	2005	SURVEY	SURVEYED
170	2005	SURVEY	SURVEYED
172	2005	SURVEY	SURVEYED
177	2005	SURVEY	SURVEYED
183	2005	SURVEY	SURVEYED
187	2005	SURVEY	SURVEYED
191	2005	SURVEY	SURVEYED
196	2005	SURVEY	SURVEYED
200	2005	SURVEY	SURVEYED
206	2005	SURVEY	SURVEYED
207	2005	SURVEY	SURVEYED
167	2005	DROP	SAFETY (LOGGING ACTIVITY)
176	2005	DROP	SAFETY
1	2005	DROP	NO SURFACE FLOW
21	2005	DROP	NO SURFACE FLOW
133	2005	DROP	NO SURFACE FLOW
135	2005	DROP	NO SURFACE FLOW
143	2005	DROP	NO SURFACE FLOW
181	2005	DROP	NO SURFACE FLOW
185	2005	DROP	NO SURFACE FLOW
193	2005	DROP	NO SURFACE FLOW
195	2005	DROP	NO SURFACE FLOW
13	2005	DROP	NO SURFACE CONNECTIVITY
15	2005	DROP	NO SURFACE CONNECTIVITY
139	2005	DROP	NO SURFACE CONNECTIVITY
149	2005	DROP	NO SURFACE CONNECTIVITY

173	2005	DROP	NO SURFACE CONNECTIVITY
14	2005	DROP	LANDOWNER DENIAL
147	2005	DROP	LANDOWNER DENIAL
202	2005	DROP	LANDOWNER DENIAL
192	2005	DROP	INACCESSIBLE (EARLY SEASON)
8	2005	DROP	INACCESSIBLE
164	2005	DROP	IN LAKE (TWIN LAKES)
16	2005	DROP	IN LAKE (LAKE JULIUS)
2	2005	DROP	ABOVE BARRIER
18	2005	DROP	ABOVE BARRIER
22	2005	DROP	ABOVE BARRIER
25	2005	DROP	ABOVE BARRIER
126	2005	DROP	ABOVE BARRIER
136	2005	DROP	ABOVE BARRIER
150	2005	DROP	ABOVE BARRIER
151	2005	DROP	ABOVE BARRIER
156	2005	DROP	ABOVE BARRIER
166	2005	DROP	ABOVE BARRIER
179	2005	DROP	ABOVE BARRIER
182	2005	DROP	ABOVE BARRIER
184	2005	DROP	ABOVE BARRIER
188	2005	DROP	ABOVE BARRIER
190	2005	DROP	ABOVE BARRIER
197	2005	DROP	ABOVE BARRIER
198	2005	DROP	ABOVE BARRIER
201	2005	DROP	ABOVE BARRIER
204	2005	DROP	ABOVE BARRIER
165	2005	DROP	2005 NO CONNECTIVITY
169	2005	DROP	2005 NO CONNECTIVITY
189	2005	DROP	2005 NO CONNECTIVITY
205	2005	DROP	2005 NO CONNECTIVITY
163	2005	DROP	2005 BARRIER
12	2005	DROP	2005 BARRIER
162	2005	DROP	2005 BARRIER
175	2005	DROP	2005 BARRIER
194	2005	DROP	2005 BARRIER
WC503432-003	2004	WDFW	WDFW
WC503432-017	2004	WDFW	WDFW

WC503432-018	2004	WDFW	WDFW
WC503432-036	2004	WDFW	WDFW (not index)
WC503432-038	2004	WDFW	WDFW
WC503432-039	2004	WDFW	WDFW
WC503432-061	2004	WDFW	WDFW
WC503432-001	2004	SURVEY	SURVEYED
WC503432-009	2004	SURVEY	SURVEYED
WC503432-011	2004	SURVEY	SURVEYED
WC503432-015	2004	SURVEY	SURVEYED
WC503432-021	2004	SURVEY	SURVEYED
WC503432-022	2004	SURVEY	SURVEYED
WC503432-024	2004	SURVEY	SURVEYED
WC503432-025	2004	SURVEY	SURVEYED
WC503432-027	2004	SURVEY	SURVEYED
WC503432-029	2004	SURVEY	SURVEYED
WC503432-032	2004	SURVEY	SURVEYED
WC503432-035	2004	SURVEY	SURVEYED
WC503432-042	2004	SURVEY	SURVEYED
WC503432-046	2004	SURVEY	SURVEYED
WC503432-047	2004	SURVEY	SURVEYED
WC503432-048	2004	SURVEY	SURVEYED
WC503432-049	2004	SURVEY	SURVEYED
WC503432-054	2004	SURVEY	SURVEYED
WC503432-055	2004	SURVEY	SURVEYED
WC503432-058	2004	SURVEY	SURVEYED
WC503432-060	2004	SURVEY	SURVEYED
WC503432-063	2004	SURVEY	SURVEYED
WC503432-152	2004	SURVEY	SURVEYED
WC503432-153	2004	SURVEY	SURVEYED
WC503432-155	2004	SURVEY	SURVEYED
WC503432-020	2004	DROP	SITE GENERATION ERROR (SIDE CHANNEL)
WC503432-062	2004	DROP	NO SURFACE CONNECTIVITY
WC503432-004	2004	DROP	NO SURFACE CONNECTIVITY
WC503432-064	2004	DROP	NO SURFACE CONNECTIVITY
WC503432-050	2004	DROP	NO SURFACE CONNECTIVITY
WC503432-044	2004	DROP	NO SURFACE CONNECTIVITY
WC503432-030	2004	DROP	NO SURFACE CONNECTIVITY
WC503432-005	2004	DROP	NO SURFACE CONNECTIVITY

WC503432-016	2004	DROP	INACCESSIBLE
WC503432-157	2004	DROP	ABOVE BARRIER
WC503432-156	2004	DROP	ABOVE BARRIER
WC503432-154	2004	DROP	ABOVE BARRIER
WC503432-151	2004	DROP	ABOVE BARRIER
WC503432-059	2004	DROP	ABOVE BARRIER
WC503432-057	2004	DROP	ABOVE BARRIER
WC503432-056	2004	DROP	ABOVE BARRIER
WC503432-053	2004	DROP	ABOVE BARRIER
WC503432-051	2004	DROP	ABOVE BARRIER
WC503432-045	2004	DROP	ABOVE BARRIER
WC503432-043	2004	DROP	ABOVE BARRIER
WC503432-041	2004	DROP	ABOVE BARRIER
WC503432-037	2004	DROP	ABOVE BARRIER
WC503432-033	2004	DROP	ABOVE BARRIER
WC503432-031	2004	DROP	ABOVE BARRIER
WC503432-023	2004	DROP	ABOVE BARRIER
WC503432-019	2004	DROP	ABOVE BARRIER
WC503432-014	2004	DROP	ABOVE BARRIER
WC503432-013	2004	DROP	ABOVE BARRIER
WC503432-010	2004	DROP	ABOVE BARRIER
WC503432-008	2004	DROP	ABOVE BARRIER
WC503432-007	2004	DROP	ABOVE BARRIER
WC503432-002	2004	DROP	ABOVE BARRIER
WC503432-052	2004	DROP	2004 BARRIER (HATCHERY)
WC503432-040	2004	DROP	2004 BARRIER (HATCHERY)
WC503432-034	2004	DROP	2004 BARRIER (HATCHERY)
WC503432-028	2004	DROP 2004	2004 BARRIER (HATCHERY)
WC503432-026	2004	DROP	2004 BARRIER (HATCHERY)
WC503432-012	2004	DROP 2004	2004 BARRIER (HATCHERY)
WC503432-006	2004	DROP 2004	2004 BARRIER (HATCHERY)

Appendix B: Redd Categorization Definitions

Incomplete: A steelhead has disturbed the substrate, but there is not a clear pit and tail.

Complete: Gravels are clean due to fish activity and there is a distinct pit and tail.

Faded: Still visible, but may be “flattened out” or no longer bright (algal growth).

Erased: A surveyor would not identify it as this year’s redd had it not already been surveyed.